What is claimed is:

[Claim 1] 1. A membrane-electrode-assembly (MEA) for an electrochemical cell employing a gas, the MEA comprising:

a proton exchange membrane;

a first electrode disposed on one side of the membrane;

a second electrode disposed on the opposite side of the membrane; and

a metallic layer disposed between the membrane and the first electrode, the membrane and the second electrode, or both;

wherein the metallic layer has a composition and thickness suitable for reducing the amount of gas crossover at the membrane by equal to or greater than about 20% as compared to the amount of gas crossover at the membrane in the absence of the metallic layer.

[Claim 2] 2. The MEA of Claim 1, wherein the gas comprises hydrogen.

[Claim 3] 3. The MEA of Claim 2, wherein:

the metallic layer has a composition and thickness suitable for reducing the amount of hydrogen crossover at the membrane by equal to or greater than about 30% as compared to the amount of hydrogen crossover at the membrane in the absence of the metallic layer.

[Claim 4] 4. The MEA of Claim 2, wherein:

the metallic layer comprises platinum, gold, or any combination comprising at least one of the foregoing.

[Claim 5] 5. The MEA of Claim 2, wherein:

the metallic layer is semicontinuous.

[Claim 6] 6. The MEA of Claim 2, wherein:

the metallic layer is porous.

[Claim 7] 7. The MEA of Claim 2, wherein:

the metallic layer is pervious to hydrogen ions.

[Claim 8] 8. The MEA of Claim 2, wherein;

the metallic layer covers equal to or greater than about 20% of the active area of the membrane.

[Claim 9] 9. The MEA of Claim 8, wherein:

the metallic layer covers equal to or greater than about 30% of the active area of the membrane.

[Claim 10] 10. The MEA of Claim 2, wherein:

the metallic layer is deposited on a surface of the membrane.

[Claim 11] 11. The MEA of Claim 10, wherein:

the metallic layer is deposited on the surface of the membrane via plating, chemical reduction, or ion beam assisted deposition.

[Claim 12] 12. The MEA of Claim 2, wherein:

the metallic layer has a thickness equal to or greater than about 1 molecule thickness.

[Claim 13] 13. The MEA of Claim 12, wherein:

the metallic layer has a thickness equal to or greater than about 1 micro-inch.

[Claim 14] 14. The MEA of Claim 13, wherein:

the metallic layer has a thickness equal to or greater than about 1 mil.

[Claim 15] 15. The MEA of Claim 2, wherein:

the first electrode is disposed on the oxygen electrode side of the MEA;

the second electrode is disposed on the hydrogen electrode side of the MEA; and

the metallic layer is disposed only between the membrane and the second electrode.

[Claim 16] 16. An electrochemical cell, comprising:

a plurality of membrane-electrode-assemblies (MEAs) alternatively arranged with a plurality of flow field members between a first cell separator plate and a second cell separator plate;

wherein at least one MEA comprises:

a proton exchange membrane;

a first electrode disposed on one side of the membrane;

a second electrode disposed on the opposite side of the membrane; and

a metallic layer disposed between the membrane and the first electrode, the membrane and the second electrode, or both;

wherein the metallic layer has a composition and thickness suitable for reducing the amount of hydrogen crossover at the membrane by equal to or greater than about 20% as compared to the amount of hydrogen crossover at the membrane in the absence of the metallic layer; and

wherein the metallic layer has a composition and thickness suitable for operating the electrochemical cell at an operating pressure difference across the at least one MEA of equal to or greater than about 50 pounds-per-square-inch (psi).

[Claim 17] 17. The electrochemical cell of Claim 16, wherein:

the metallic layer comprises a semicontinuous or porous layer suitable for reducing the amount of hydrogen crossover at the membrane by equal to or greater than about 30% as compared to the amount of hydrogen crossover at the membrane in the absence of the metallic layer.

[Claim 18] 18. The electrochemical cell of Claim 16, wherein:

the metallic layer comprises a semicontinuous or porous layer of platinum, gold, or any combination comprising at least one of the foregoing.

[Claim 19] 19. An electrolysis cell, comprising:

a plurality of membrane-electrode-assemblies (MEAs) alternatively arranged with a plurality of flow field members between a first cell separator plate and a second cell separator plate;

wherein at least one MEA comprises:

a proton exchange membrane;

a first electrode disposed on one side of the membrane;

a second electrode disposed on the opposite side of the membrane; and

a metallic layer disposed between the membrane and the first electrode, the membrane and the second electrode, or both;

wherein the metallic layer has a composition and thickness suitable for reducing the amount of hydrogen crossover at the membrane by equal to or greater than about 20% as compared to the amount of hydrogen crossover at the membrane in the absence of the metallic layer; and

wherein the metallic layer has a composition and thickness suitable for operating the electrochemical cell at an operating pressure difference across the at least one MEA of equal to or greater than about 100 pounds-per-square-inch (psi).

[Claim 20] 20. The electrochemical cell of Claim 19, wherein:

the metallic layer comprises a semicontinuous or porous layer suitable for reducing the amount of hydrogen crossover at the membrane by equal to or greater than about 30% as compared to the amount of hydrogen crossover at the membrane in the absence of the metallic layer.

[Claim 21] 21. The electrolysis cell of Claim 19, wherein:

the metallic layer comprises a semicontinuous or porous layer of platinum, gold, or any combination comprising at least one of the foregoing.